

# AI for Earth Grantee Profile

Long Live the Kings

Salish Sea Marine Survival Project



## Summary

Long Live the Kings is developing an ecosystem model on Microsoft Azure to answer critical questions facing salmon recovery and sustainable fisheries in the Salish Sea. On Azure, researchers can run up to ten simulations at a time and get results in days instead of weeks—propelling research that informs ecosystem management and policy decisions.

## Using the power of Azure to save salmon in the Salish Sea

Salmon are an important part of Pacific Northwest culture—they are deeply rooted in Native American traditions, the health of the local sea, and the core of a multi-billion-dollar fishing industry. Hundreds of millions of dollars have been invested in hatchery and harvest reform and in habitat protection and restoration to protect the local salmon populations.

Chinook and coho salmon and steelhead populations in the Salish Sea have declined by up to 90 percent in recent decades.

However, marine survival—the time a fish spends in the water as a juvenile before it returns to its stream of origin—is declining in some parts of the Pacific Northwest. Chinook and coho salmon and steelhead populations in the Salish Sea have declined by up to [90 percent](#), and their abundance remains well below what it was 30 years ago. Salmon populations in coastal rivers have not shown the same declines, suggesting that the problem lies within the Salish Sea.

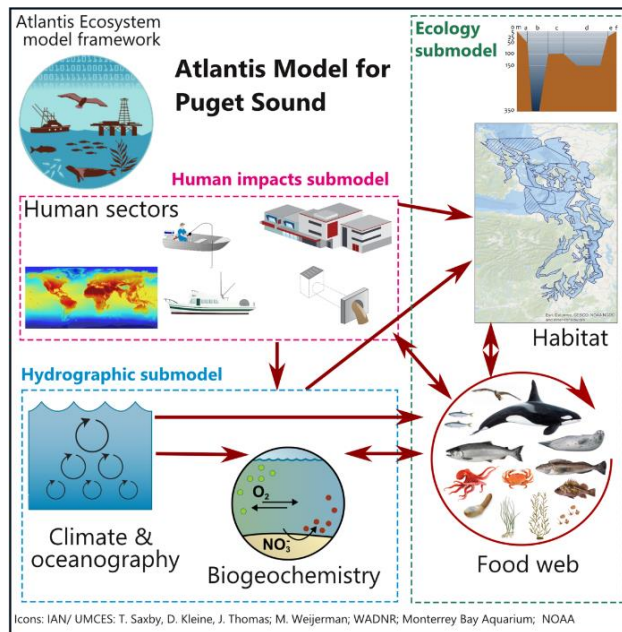
The Salish Sea ecosystem has changed significantly over the past 30 years, and the problems facing its salmon are likely due to the interaction of many overlapping factors. These include changing water temperatures, reductions in food supply such as plankton and forage fish, marine mammal increases, contaminants, and disease, to name a few.

Finding solutions to address why salmon are dying in the Salish Sea is critical to realizing the full value of the region’s significant salmon recovery efforts—as well as ensuring future generations grow up with these economically and culturally important species.

## Building a comprehensive model to implement real-world actions

Established in 2014 by LLTK and the Pacific Salmon Foundation, the [Salish Sea Marine Survival Project](#) (SSMP) brings together an international team of scientists and managers from dozens of federal, state, tribal, academic, private, and nonprofit organizations to determine why juvenile salmon and steelhead are dying in the Salish Sea.

In partnership with the [Pacific Salmon Foundation](#) of Canada, LLTK coordinates more than 60 organizations in conducting a holistic, transboundary effort to study the physical, chemical, and biological factors affecting salmon and steelhead survival and sustainable fisheries. The SSMP serves as a model for ecosystem-scale collaborative science. Its results will facilitate smarter management and stronger returns.



Visualization of the Atlantis model for Puget Sound.  
[Courtesy Long Live the Kings, NOAA Fisheries]

Researchers at the SSMP are bringing together data from across these groups to assess young salmon and steelhead growth, health, and diet; track fish and marine mammal movements through acoustic telemetry; monitor marine conditions; and develop an intensive ecosystem model of the Salish Sea, using the “Atlantis” ecosystem model to answer critical questions facing salmon recovery and sustainable fisheries. Atlantis is a flexible, modular modeling framework capable of producing realistic simulations of ecosystem dynamics.

Results from the Salish Sea ecosystem model will be used to implement real-world actions that improve hatchery, harvest, and ecosystem management and inform habitat protection and restoration. Along the way, researchers are ensuring that the findings of this comprehensive ecological effort broadly inform Salish Sea ecosystem recovery—from forage fish to birds to threatened orca whales.

### Getting faster to recovery—with more confidence

In December 2017, Long Live the Kings was awarded a grant from Microsoft as part of the AI for Earth program. LLTK is using the AI for Earth grant to improve the speed and capabilities of the Atlantis model, thereby propelling research that can inform ecosystem management and policy decisions. “We’re leveraging both the processing power and machine learning capabilities of Azure to look at various impacts and test outcomes within the ecosystem model,” says Michael Schmidt, the Deputy Director of Long Live the Kings.



*Field work sampling juvenile salmon for the Salish Sea Marine Survival Project.  
[Photo courtesy Long Live the Kings]*

Until recently, a single simulation in the Atlantis model could take weeks to complete. By spring of 2019, Schmidt expects researchers will be able to run up to ten simulations at a time and get results in days instead of weeks. With this new capability, researchers can dig into much more complicated questions, for example comparing hundreds of slightly different answers to one question about available food and its effects on survival rates. The ability to run more simulations quickly will also help reduce uncertainty within the model, critical to assuring buy-in of its results by managers and the public.

“Machine learning is often applied to areas where you have lots of uncertainty, where there are lots of unknowns, and where you’re trying to process a lot of information,” Schmidt says. “And that’s exactly what we’re trying to do. We’re trying to understand a very complex ecosystem with a limited amount of information and basically put the puzzle together.”

The Azure platform will also help LLTK address requests from managers and stakeholders faster, thereby improving public engagement and enhancing the value of model outputs. Schmidt adds, “We will be able to scale up to address other ecosystem issues, such as the Southern resident orca whales. The Salish Sea ecosystem model can help quickly inform that task force—which may only be around for a short period of time. That’s very powerful.”

## Going forward

Over the next few months, LLTK is focused on parameterizing the model and plans to start running scenarios in spring 2019. The next year and a half will be critical to finishing the work and reporting out holistically on the most significant impacts to the fish using the Atlantis model.

LLTK works arm-in-arm with NOAA and other experts on salmon recovery, and ultimately plans to pass these tools to them so they become a part of the overall ecological management framework.

## About Long Live the Kings

[Long Live the Kings](#) (LLTK) works to restore wild salmon and steelhead populations and support sustainable fishing in the Pacific Northwest. Since its founding in 1986, LLTK has combined innovative field work, pioneering science, broad partnerships, and sophisticated new management tools to help decision-makers advance salmon recovery while balancing the needs of fish and people.

## Resources

### Websites

[Salish Sea Marine Survival Project](#)

[Long Live the Kings](#)

[Atlantis ecological model](#)

[AI for Earth](#)

### Press

Pailthorp, Bellamy. “[Microsoft Grant Shows How Artificial Intelligence Could Help Salmon Recovery](#)”. KNKX Public Radio. January 2, 2018.

## Publications

Zimmerman et al. (2015) "[Spatial and temporal patterns in smolt survival of wild and hatchery coho salmon in the Salish Sea.](#)" *Marine and Coastal Fisheries*, 7:1, 116-134. DOI: 10.1080/19425120.2015.1012246.

Ruff et al. (2017) "[Salish Sea Chinook salmon exhibit weaker coherence in early marine survival trends than coastal populations.](#)" *Fisheries Oceanography*, 26:6, 625-637. DOI: 10.1111/fog.12222.

Kendall et al. (2017) "[Declining patterns of Pacific Northwest steelhead trout \(\*Oncorhynchus mykiss\*\) adult abundance and smolt survival in the ocean.](#)" *Canadian Journal of Fisheries and Aquatic Sciences*, 74:8, 1275-1290. DOI: 10.1139/cjfas-2016-0486.